s5.m2.o3 The new analytical high-resolution electronmicroscopes – the perfect tool for nanoscience.

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How would you like to buy an ultimate grade high resolution electron microscope which damages your sample less and fits into a normal room – at less than a quarter of the price today?

This may well be a reality within 1-2 years from now. The three major technical improvements which has made this possible is:

Better electron sources. Field emission guns (FEG) has been developed which gives a brightness exceeding 10^{13} $Am^{-2} sr^{-1}$ and an energy spread of less than 0.7 eV together with high spatial coherence.

Monochromators. By inserting a Wien filter and a selecting slit before the sample, at a low-energy section of the incident beampath (between the gun and the accelerator, or after retarding lenses) the energy spread of the beam can be further reduced down to 0.012 eV. This enables highly resolved EEL spectra, where details of electronic structure can be analysed from the near-edge structure (ELNES), and even used for imaging.

Lens aberration correctors. The capability of an electron microscope has since the 1940ies been defined by the so called Scherzer resolution:

$$u_{Sch} = 0.66\, C_s^{1/4}\, \lambda^{3/4}$$

Where u is the closest point-to-point distance that can be transmitted through the microscope in the first passband at optimum defocus (i.e. with the correct phase). Note that the accuracy in atomic positions is usually far better than the point resolution. From the formula we see that we can improve the resolution by lowering the spherical aberration constant, C_s, or use shorter wavelength, i.e. larger accelerators. It was suggested more than 50 years ago that the spherical abberation could in principle be corrected by an additional set of multipole lenses [1], and just recently this has also been accomplished in practise [2] on a 200kV FEG-TEM, lowering the point resolution from 0.24 nm to 0.14 nm on this prototype.

Applying the C_s corrector to a 300 kV analytical FEG-TEM, we would be able to acquire chemical analysis on the sub-nm level, combined with imaging resolution around 0.10 nm, which is the same as for present-day 1.25 MV microscopes (height: 10-15 m).

However, we would get a different type of images, due to the different shape of the transmission function, and the optimum defocus calculation used today would no longer be the best setting, and the Sherzer resolution has to be reformulated. The limit will be set by the temporal coherence envelope, which includes the energy spread of the source and the chromatic aberrations of the lenses, rather than the phase contrast transfer function, unless a monochromator is included.

[1] O. Scherzer, *Optik*, (1947) 2: 114
[2] M. Haider, H. Rose, S. Uhlemann, E. Schwan, B. Kabius and K. Urban, *Nature,* (1998) 392, 768-769

s5.m2.o4 Total external fluorescence and XRSW study of multilayer nanostructures.

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Keywords: diffraction, fluorescence, multilayer.

The achievements of nanotechnology in design and construction of man-made organic and inorganic multilayers demand the adequate nondestructive characterization techniques on nanometric scale.

The development of x-ray standing wave method, total external fluorescence study, x-ray wave-guide mode formation are presented and used for characterization of inorganic nanostructures. They allow to obtain thickness, density and roughness of ultra thin films imbedded in a multilayer, to detect alien interfacial layers, to get information about interdiffusion at the interfaces, to investigate x-ray mirror degradation under heat load; to follow ion permeation through Langmuir-Blodgett films and organic mono and bilayers on water surface - models of biomembranes [1-3].

[1] S.I.Zheludeva, M.V.Kovalchuk, N.N.Novikova, A.N.Sosphenov, N.E.Malysheva, N.N.Salaschenko, A.D.Akhsakhaljan, Yu.Ja.Platonov, R.I.Cernik, S.P.Collins. Thin Sollid Films 259 (1995) 131.
[2] S.I.Zheludeva, M.V.Kovalchuk, N.N.Novikova, A.N.Sosphenov, M.C.Petty, V.A.Howarth, R.I.Cernik, S.P.Collins. Mat. Science and Engineering: C3 (1995) 211.
[3] S.I.Zheludeva, M.V.Kovalchuk, N.N.Novikova, A.N.Sosphenov, N.N.Salaschenko, E.A.Shamov, K.A.Prokhorov, E.Bburattini, G.Cappuccio J. Appl. Cryst. 29 (1997) 203.